Documents attached to September 20, 1999, comment letter from San Joaquin River Exchange Contractors Water Authority (comment letter no. 1062)

- The Role and Value of Agricultural in the San Joaquin River Exchange Contractors' Service Area

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NORTHWEST ECONOMIC
ASSOCIATES

The Role and Value of Agriculture in the San Joaquin River Exchange Contractors' Service Area

Prepared for

San Joaquin River Exchange Contractors Water Authority
836 6th Street
Los Banos, CA 93635

Prepared by

Northwest Economic Associates
555 Capitol Mall, Suite 740
Sacramento, CA 95814

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I Highlights

The San Joaquin River Exchange Contractors Water Authority (Exchange Contractors) includes four separate entities: the Central California Irrigation District (CCID), San Luis Canal Company (SLCC), Firebaugh Canal Water District (FCWD), and Columbia Canal Company (CCC). The four entities or their precedent organizations are integral parts of the agricultural history of California.

The west San Joaquin Valley is one of the most important regional agricultural economies in the United States. Within the region, farmers in the Exchange Contractors' service area produce more than 75 crops with a farm value of $250,000,000 per year. In addition, the service area is home to a large dairy sector that produces $80,000,000 of farm output and $82,000,000 of processed products per year. The history of the Exchange Contractors is an important part of California history, and land in the service area has been farmed intensively and irrigated for more than 100 years. During this time, both a large, diversified farm production sector and a complex of supporting goods- and service-providing businesses have developed.

The entire west San Joaquin Valley regional economy built up around agriculture. And agriculture has developed in the region because of the availability and beneficial, efficient use of irrigation water. While groundwater was used extensively in the early 1900s, the development of CVP facilities provided surface water sufficient to reverse the pattern of overdrafting that has characterized the San Joaquin Valley for decades.

Farms in the Exchange Contractors' service area are primarily family operations averaging 200-600 acres. They provide employment for many families and also for hired labor. They provide a wide variety of products for both domestic and foreign markets. They are principal suppliers of some specialty crops that are grown in few other places in the country or world.

Annual crops make up 92 percent of the 225,000 acres of cropland in the service area. Cotton is the largest single crop grown in the area and represents 36 percent of total acreage and 41 percent of total production value. Other high-value annual crops grown in the service area include a variety of vegetables such as tomatoes, garlic, and

melons; and alfalfa hay, which is used extensively by the local dairy industry. The largest acreage of permanent crops is in walnuts, although the largest value among permanent crops in the area is in almonds.

Agriculture is the primary or only sector present in parts of the service area. While Los Banos has undergone urbanization and is somewhat less dependent upon agriculture than it was in the 1960s, other parts of the service area remain highly dependent on farming. For the entire Central Valley, farming and farm-related industries account for 27-28 percent of jobs and income. The figures are at least twice that level for some parts of the Exchange Contractors' service area.

Cropping patterns have changed modestly in the service area. These changes reflect such factors as market forces, water availability, and agronomic issues. Total cropped acreage has changed little, while alfalfa acreage has increased 47 percent, cotton 27 percent, and vegetables 68 percent. Acreage of field crops has fallen 36 percent, grains have fallen 29 percent, and tree nuts have fallen 31 percent.

The service area covers parts of Fresno, Madera, Merced, and Stanislaus Counties. The role and importance of agriculture varies among and within those counties. So do the extent of linkages from farm production to other sectors. Measured across all production sectors, farming has widespread multiplier impacts throughout the regional economy. A unit change in farming employment eventually ripples through to a total change of 3.5 employees regionwide. A $1.00 change in crop production increases to a change of more than $2.00 after all linkages are considered.

Farmers in the service area purchase inputs valued at more than $167,000,000 annually for crop and dairy production. Nearly 60 percent of these inputs originate locally, and the agribusiness complex that has developed around production agriculture is large and diverse. For some crops, the local content is even higher.

Farmers in the service area have annual payrolls of more than $28,000,000. Both family and hired labor are employed in large numbers. Farms in the service area generate more than $7,000,000 in sales and other local taxes and provide more than $127,000,000 in taxable salary and rent and profit income.

Farm products from the service area move to many domestic and foreign markets. Most cotton is exported from the area, 76 percent to other domestic markets and 21 percent to foreign markets. Almost 80 percent of hay is used locally because of high transportation costs to more distant markets. Most of the locally-used hay is purchased by dairies, followed by cattle operations and feedlots, poultry and egg producers, and feed preparers. Other farm products from the service area are also used locally, and the ripple effects extend to almost all sectors of the regional economy.

Irrigators in the service area are prudent, efficient water managers. They utilize a variety of methods to minimize water waste while also minimizing crop stress. Some

farmers have installed sprinkler and drip systems, while others have not because of incompatible soil or topography conditions. All farmers closely monitor soil and weather conditions in order to irrigate at the most appropriate times.

The Exchange Contractors have been instrumental in encouraging water efficiency and conservation by farmers in the service area. The Exchange Contractors have utilized tiered pricing for almost a decade and have found broad acceptance for the approach. In addition, the Exchange Contractors have established conservation loan programs to fund, at low interest rates, such water conserving projects as concrete canal lining, land leveling, and surface or underground pipelines. Thus far, projects completed under these programs save more than 10,000 acre-feet of water annually.

Farmers in the Exchange Contractors' service area use water efficiently, beneficially, and with minimum waste. Farmers in the service area understand that water has helped to make this an integral part of one of the most important agricultural regions in the nation. The development of an efficient, intensively-farmed production sector in the service area has spawned the creation of a large complex of industries purchasing from and selling a large variety of goods and services to farms. Agriculture and agriculture-related businesses remain cornerstones of the Exchange Contractors' service area, and there will be few economic alternative uses for these lands for many years.

This report addresses the importance of agriculture in the regional economy that includes the Exchange Contractors' service area. While the discussion, data, and impacts presented are regional in nature, the importance of the service area stretches well beyond its geographic boundaries. Consequently, the importance of agriculture and related industries is best understood when viewed relative to the region rather than to the total state economy. In addition, however, it is clear that these industries have imprint effects on the entire San Joaquin Valley and beyond.

II Introduction

Background and Key Issues

The San Joaquin Valley is the cornerstone of California agriculture and is home to production of nearly eight billion dollars of crop and livestock products annually. Within the western San Joaquin Valley, the service area of the Exchange Contractors includes more than 225,000 acres of highly productive land in Fresno, Madera, Merced, and Stanislaus Counties. Farm sales in three of those counties, Fresno, Merced, and Stanislaus, exceed $1 billion annually.

Farmers in the Exchange Contractors' service area produce more than 75 annual and permanent crops as well as many livestock products. Many of the crops are specialty products, grown in few or no other places in the country or world. The agricultural products of the area are sold in a large number of domestic markets, and also are an important component of California agricultural exports. The service area has a rich agricultural history, and agriculture is the nucleus of the regional economy.

The Exchange Contractors' service area is also home to a large dairy sector that is integral to the production and processing sectors of the entire regional economy. Dairy operations in the area account for 10 percent of the total output in the four-county area [1]. The dairy sector is an important source of demand for locally-produced alfalfa and other feeds, and also provides a consistent flow of high-quality milk that is processed almost entirely in the local area.

[1] Based on the estimated number of milking and non-milking cows on dairy farms in the service area relative to the number on farms in the entire four-county area. See [U.S. Department of Commerce 1994; Agricultural Commissioners' Reports for Fresno, Madera, Merced, and Stanislaus Counties, 1994 and 1995].

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While some parts of the Exchange Contractors' service area are undergoing urbanization, most of the region is dominated by agriculture and is likely to remain in agriculture for the foreseeable future. And, while agriculture uses many inputs in addition to water, few of the crops produced today in the service area would be feasible without irrigation. Consequently, the availability and reliability of high-quality irrigation water are critical to the total regional economy.

Purpose and Organization of Study

The purpose of this study is to evaluate the role and value of agriculture in the regional economy of the Exchange Contractors' service area. Agriculture and agriculturally-related businesses are much more important to the local economy than what is suggested by statewide averages. For example, while agriculture and agribusiness sectors account for 9 percent of California jobs and personal income, they account for more than 27 percent in the total Central Valley and more than 50 percent in parts of the San Joaquin Valley [2].

Because of this critical dependence, there is a clear need for information on the unique stabilizing role of agriculture and on the many beneficial ways in which water supplies are used in the service area. This applies to the entire area, particularly given the many small communities and rural areas that are largely or totally dependent upon agriculture and agriculture-related businesses. This report addresses both of these information needs.

The study is organized into six chapters. Following the introduction is a history of the Exchange Contractors. It includes the purposes of their organization, how it was created, and the origins of their water supplies and rights. Next is a detailed description of agriculture in the service area, including farm characteristics, crop diversity, value of production, changing crop patterns, dairy production, and the role of agriculture as a stabilizing force in the region. Discussion then moves to the dependence of the area on agriculture, including estimates of outputs and employment in various agriculture and agriculture-related sectors, the agricultural concentration of certain sub-areas of the region, and comparisons of the area to the state. Irrigation is then reviewed, including surface and ground water utilization, water use efficiency, water pricing, and conservation.

[2] See Carter and Goldman [1996]; Archibald [1990]; and US Bureau of Census [1992].

III History of The Exchange Contractors Authority

Purposes of the Organization

The San Joaquin River Exchange Contractors Water Authority (Exchange Contractors) includes four separate entities: the Central California Irrigation District (CCID), San Luis Canal Company (SLCC), Firebaugh Canal Water District (FCWD), and Columbia Canal Company (CCC). The four entities or their precedent organizations are integral parts of the agricultural history of California.

The Authority was formed by a joint powers agreement, and its office was opened in Los Banos in January 1993. The mission of the Authority itself is to monitor environmental, legislative, and legal issues which impact the operations or water rights of the Exchange Contractors.

History of the Exchange Contractors and of the Authority

The Exchange Contractors hold Miller and Lux water rights, some of the oldest water rights in California, dating back to the 1880s. Construction on the San Joaquin and Kings River Canal Company canals began in the 1870s [Prokopovich 1989]. The Main canal, from Mendota Pool to Los Banos, was completed in 1871, and was extended to Newman in 1878; it was extended to the Crows Landing area in the 1880s. Henry Miller acquired control of the Main Canal and constructed the Outside Canal in the 1870s and 1880s. These waters were used to irrigate Miller's acreage throughout the area. (See Treadwell [1931]).

Because of this early water usage, the water rights of the Exchange Contractors are based on their riparian and pre-1914 diversions. When construction of the Friant Dam was under consideration, the importance of water to agricultural development in the east San Joaquin Valley became apparent. The Exchange Contractors thus were

asked by the United States in the 1930s to exchange their rights to San Joaquin River and Kings River water for guaranteed deliveries of "substitute" water from the Sacramento River delivered by the Delta-Mendota Canal (DMC).

The Exchange Contract was signed in 1939. By its terms, the Exchange Contractors are guaranteed 100 percent of their contractual water allotment in normal years and approximately 75 percent in critical years. The United States began to serve the Exchange Contractors with Delta-Mendota Canal (DMC) water in 1951. By terms of the contract and amendments to it, the Bureau of Reclamation (Bureau) is responsible for the operation of the DMC and delivery of contracted amounts of water to the Exchange Contractors. The Exchange Contractors are jointly responsible for allocating the delivered water among themselves based on acreage and conditions required to obtain the highest possible beneficial use from the water.

By the 1939 contract, the Exchange Contractors maintained their San Joaquin River water rights, but agreed not to exercise those rights if they receive guaranteed deliveries through the DMC or from other Bureau sources. If the Bureau is unable to deliver the contracted amounts of water, the Exchange Contractors have the right to divert San Joaquin River water under their historic water rights.

Water Supplies

The Exchange Contractors are entitled to receive 840,000 acre-feet of DMC or substitute surface water per year in normal years and about 650,000 acre-feet during critically-dry years. Besides surface water, other supplies used in the area include natural precipitation, west side (Coast Range) runoff, and groundwater. The agriculture of the area depends on irrigation because natural precipitation is inadequate for the types of crops grown and because runoff from the Coast Range mountains is unpredictable.

Groundwater was the key source for irrigation water for many years. However, groundwater availability and quality conditions were and are erratic, as some parts of the service area overlay aquifers and others do not. Moreover, severe overdraft and land subsidence problems developed in some west side areas because of long histories of groundwater pumping. The availability of surface water to the area has been critical in helping to mitigate these trends [Prokopovich 1989].

IV Farming in the Exchange Contractors' Service Area

The west side of the San Joaquin Valley is one of the most productive agricultural regions in the world. Climate and water availability play an important role in this richness, as the area is characterized by a semiarid Mediterranean climate of hot, dry summers and cool, rainy winters. But because of the availability of irrigation water, the four counties in which the service area is located (Fresno, Madera, Merced, and Stanislaus) consistently have been among the top agricultural areas in California. And agriculture in the service area has gained an increasingly-important role in meeting both domestic and international agricultural market demands. Besides meeting most or all of the total U.S. demands for many specialty crops, farmers in the service area are important suppliers of cotton, walnuts, and other high-value crops for export markets.

In addition to providing a variety of products for direct use by consumers, farmers in the service area also produce large amounts of alfalfa. Alfalfa is the most important roughage used in the dairy industry, supplying 24 to 27 percent of total rations in the Central Valley [California Department of Food and Agriculture 1994]. Alfalfa is not only used extensively by the dairy industry throughout the San Joaquin Valley, but also is exported to foreign markets in cubes and other forms.

Alfalfa hay is a bulky commodity, and because of transportation costs, it is very expensive for dairy farmers to import hay from other areas or states. Generally, imports provide only a short-run increment in supplies and do not represent a viable long-run source of supply for dairy producers. Since soil, climate, and water conditions give farmers in the service area a strong competitive advantage in producing alfalfa, they in turn directly support the competitive strength of the San Joaquin Valley dairy industry.

Farm Characteristics

Farms in the service area are predominantly medium size family-run enterprises. Fewer than 2 percent are held in non-family corporations, and 79 percent are in either individual/family or family corporation ownership [Archibald 1990]. Another 19 percent are in partnerships, some of which may include families. Many of the farms have been under current or previous generations of family ownership for decades, and are managed actively rather than by absentee owners [3]. Farm size averages 200-600 acres, but varies within the region. For many of these operations, the family provides some or most of the farm labor and resides on or near the farm.

In addition to family labor, farms in the service area provide income for a large hired labor force. About 55 percent of the farms use hired farm labor and 37 percent use contract labor [Archibald 1990]. The annual payroll is estimated to exceed $34,000,000 [4].

Crop Diversity

Because the service area is so large, there is no single, dominant crop or crop type. Instead, the area has a well-diversified agricultural production sector that, in turn, supports many off-farm businesses. Within certain sub-regions, some crops are more important than others because of climate, soil, and water table considerations.

Nearly 75 different crops are produced in the service area, including a variety of field crops and grains, fruits, nuts, and vegetables. Principal crops in these categories are shown in Table 1.

[3] Personal communications, managers of Exchange Contractor water districts, November 1 and 2, 1996.

[4] See Chapter V.

Table 1
Principal Crops Grown
San Joaquin River Exchange Contractors

Field Crops/Grains	Fruits/Nuts	Vegetables
Alfalfa	Almonds	Asparagus
Barley	Apples	Beans
Canola	Apricots	Broccoli
Corn	Cherries	Cabbage
Corn Nuts	Grapes	Carrots
Cotton	Oranges	Cauliflower
Oats	Peaches	Cucumbers
Pasture	Prunes	Garlic
Rice	Walnuts	Lettuce
Safflower		Melons
Sorghum/Milo		Onions
Sudan		Peas
Sugar Beets		Peppers
Wheat		Pumpkins
		Spinach
		Squash
		Tomatoes

Value of Crop Production

In 1995, farmers in the service area produced crops with a farmgate value of almost $250 million [5]. Cotton accounted for over 40 percent, at more than $103 million. Other high-value crops produced in the area included a variety of vegetables, primarily melons and tomatoes, and alfalfa hay. Annual crops made up 92 percent of the value, and fruits and nuts made up 8 percent (see Table 2 and Figure 1).

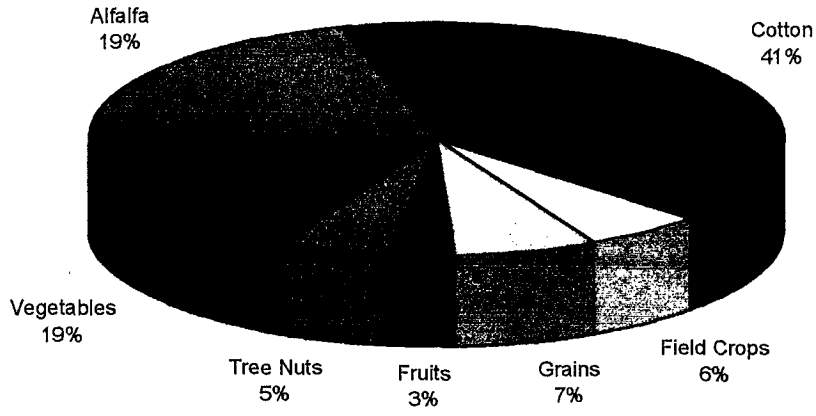
[5] Value is computed using 1995 crop acreage for the four districts, a normalized value per acre based on 1991-1995 Agricultural Commissioner reports for the four counties, and California state data. The normalized value per acre is a weighted average of those values for Fresno, Madera, and Merced Counties. The corresponding normalized yield is 2.75 bales per acre.

Table 2
1995 Value of Production [6]
San Joaquin River Exchange Contractors

	Acreage	$/Acre	Total Value
Alfalfa	**54,042**	**$880**	**$47,556,784**
Cotton	**82,129**	**$1,261**	**$103,564,039**
Field Crops	**24,247**		**$14,275,233**
Beans	11,189	$667	$7,463,063
Sugar Beets	5,005	$1,024	$5,124,710
Other Field Crops	8,053	$210	$1,687,460
Grains	**33,985**		**$16,313,474**
Corn	10,163	$528	$5,366,064
Corn Nuts	1,034	$2,951	$3,051,334
Oats	10,678	$237	$2,530,686
Rice	4,297	$639	$2,745,783
Other Grains	7,813	$335	$2,619,607
Grapes	**72**	**$3,656**	**$263,232**
Tree Fruits	**2,016**		**$7,412,251**
Apricots	669	$2,572	$1,720,668
Cherries	286	$5,395	$1,542,970
Other Tree Fruits	1,061	$3,910	$4,148,613
Tree Nuts	**6,176**		**$12,294,528**
Almonds	1,344	$2,439	$32,780,616
Walnuts	4,832	$1,866	$9,016,512
Vegetables	**22,874**		**$47,986,611**
Melons	10,016	$2,058	$20,613,545
Tomatoes	8,780	$2,187	$19,200,767
Spinach	987	$2,951	$2,912,637
Cauliflower	585	$1,934	$1,131,390
Other Vegetables	2,506	$1,647	$4,128,272
Misc. (Other)	**21**	**$392**	**$8,232**
Total	**225,562**		**$249,674,384**

[6] Acreage and value per acre are based on normalized figures from 1991-1995. Each figure is calculated as an average of three annual data points after discarding the highest and lowest magnitudes.

Figure 1
1995 Value of Production Breakdown
San Joaquin River Exchange Contractors



"Fruits" include grape acreage

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Importance as a Core Stabilizing Industry

Agriculture has been the core industry in the service area for more than 100 years. As agriculture has changed from land-extensive livestock and grain production to irrigated grain, field, fruits, nuts, and other intensively-farmed crops and dairy operations, a comprehensive infrastructure of related businesses has developed around farming. These related sectors include suppliers of purchased inputs, such as feed, seed, fertilizer, irrigation equipment, chemicals, and farm machinery; banks and other financial institutions; cotton gins; food processors; warehousing and storage businesses; and shippers and transportation companies. Moreover, since each of these industries purchases from many other sectors, agriculture has extensive ripple effects throughout the regional economy.

While large San Joaquin Valley cities such as Fresno and Bakersfield have diversified over time, agriculture is the primary or only employer in other parts of the region. Carter and Goldman [1996] estimate that farming and farm-related industries directly and indirectly create 28 percent of all jobs and 27 percent of total personal income in the Central Valley [7]. As discussed below, the percentages are much higher in parts of the Exchange Contractors' service area.

Changing Crop Patterns

Cropping patterns in the service area have changed slowly over time. These changes have occurred for many reasons, including market forces, the availability of surface water, and the development of crop varieties suitable for different soil and climate conditions. Many of the same soil and climate characteristics and market size have prevented wholesale changes in the types of crops grown.

Total cropped acreage in the service area has changed very little over the last 10 years, increasing by less than 3 percent. Acreage of some crops or crop groups has increased more measurably. These changes are summarized in Table 3 and Figures 2 and 3. They show the increased acreage of alfalfa and vegetable crops and, to a lesser extent, cotton; and the decreased acreage of grains and field crops.

Acreage of alfalfa and vegetables increased more than any other crops from 1985 through 1995, but cotton also increased significantly. Acreage of field crops, grains (including rice), and tree nuts all fell over the period. Tree fruits and grape acreage remained nearly the same. Fallow acreage decreased 70 percent, and that decline

[7] The Central Valley includes both the San Joaquin Valley and Sacramento Valley.

supported some of the growth in the various crop categories. The increase shown for Misc. (Other) is related to changes in data collection procedures by the districts rather than to changes in cropping patterns.

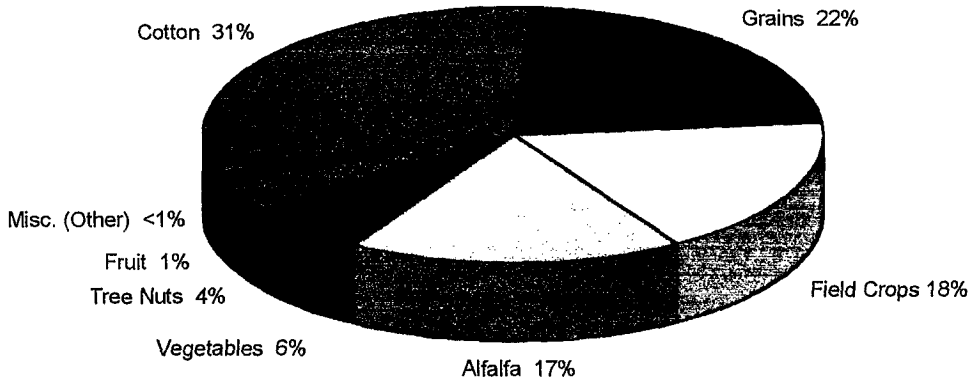
Table 3
Acreage by Crop Type
San Joaquin River Exchange Contractors

	1985	1995	Increase/ Decrease (%)
Alfalfa	36,725	54,042	+47.2%
Cotton	64,437	82,129	+27.5%
Field Crops	37,986	24,247	-36.2%
Grains	47,634	33,985	-28.7%
Grapes	72	72	0%
Tree Fruits	2,152	2,016	- 6.3%
Tree Nuts	8,931	6,176	-30.8%
Vegetables	13,575	22,874	+68.5%
Misc. (Other)	1,372	21	-98.5%
Fallow	11,272	3,382	-70.0%
Total	223,156	228,943	+ 2.6%

Since 1991, acreage in annual crops has increased only slightly. Acreage of alfalfa, cotton, and grains has increased modestly, while other field crops and vegetables have declined slightly. See Figure 4 and Table 4.

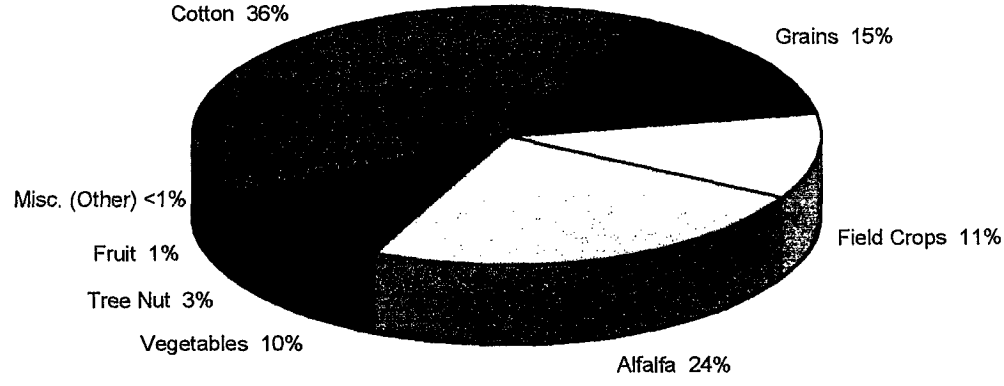
Since 1991, permanent crop acreage has increased about three percent per year, as acreage in both tree fruits and tree nuts has expanded. Grape acreage has not changed. See Figure 5 and Table 5.

Figure 2
1985 Crop Acreage by Type
San Joaquin River Exchange Contractors



"Fruit" includes grape acreage

Figure 3
1995 Crop Acreage by Type
San Joaquin River Exchange Contractors



"Fruit" includes grape acreage

Figure 4
1991-1995 Annual Crop Acreage Trends
San Joaquin River Exchange Contractors

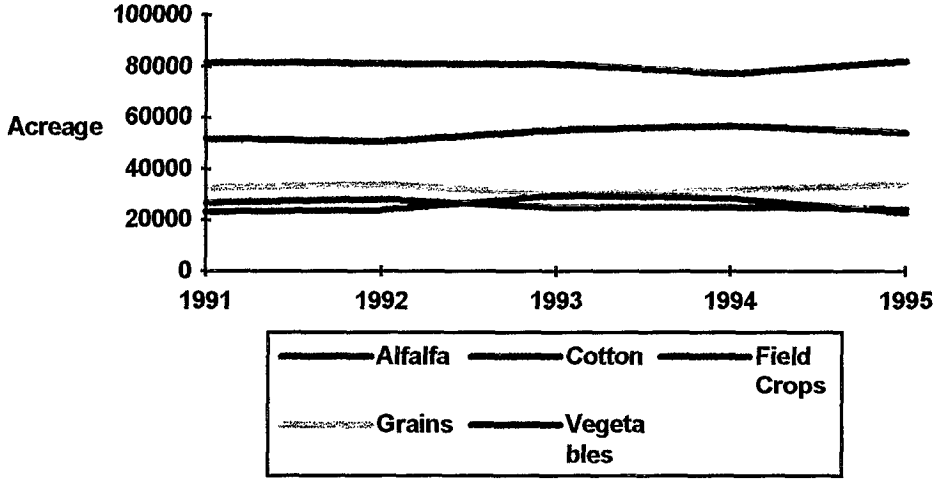


Table 4
1991-1995 Annual Crop Acreage
San Joaquin River Exchange Contractors

	Alfalfa	Cotton	Field Crops	Grains	Vegetables	Total
1991	51,936	81,819	26,781	32,447	23,048	218,022
1992	50,791	81,242	28,147	34,098	23,854	220,124
1993	55,016	80,990	24,803	29,854	29,767	222,423
1994	56,815	77,404	25,302	31,916	28,798	222,229
1995	54,042	82,129	24,247	33,985	22,874	219,272
Norm. Avg. 1991-1995	53,728	81,023	25,442	32,643	24,975	217,811

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Figure 5
1991-1995 Permanent Crop Acreage Trends
San Joaquin River Exchange Contractors

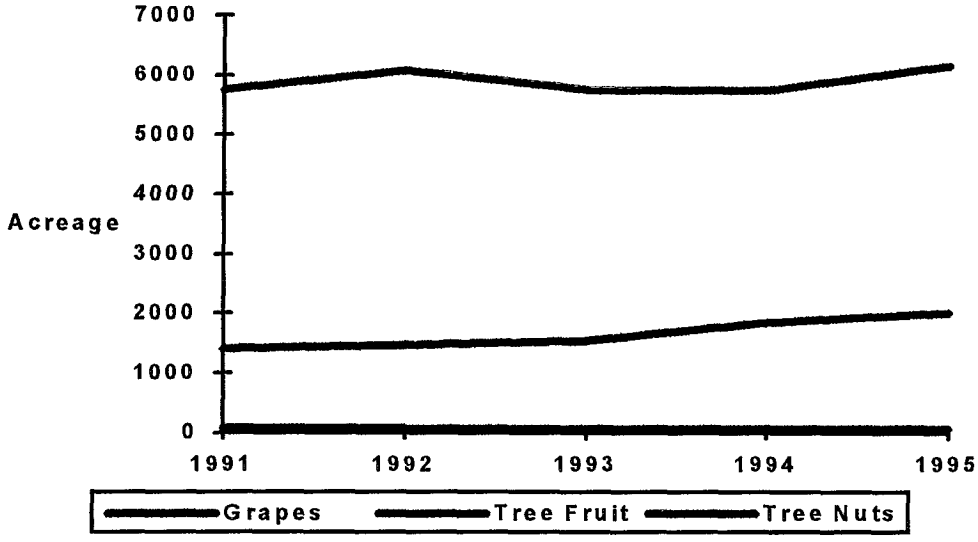

Table 5
1991-1995 Permanent Crop Acreage
San Joaquin River Exchange Contractors

	Grapes	Tree Fruits	Tree Nuts	Total
1991	76	1,402	5,747	7,225
1992	76	1,472	6,079	7,627
1993	72	1,546	5,756	7,374
1994	72	1,849	5,748	7,309
1995	72	2,016	6,176	8,264
Norm. Avg. 1991-1995	73	1,627	5,883	7,583

Dairy Production

There are about 100 dairy farms in the Exchange Contractors service area. Total herd size on these farms is about 35,000 milking and an equal number of non-milking cows. The operations account for about 10 percent of the total dairy farm sector in the 4-county area and produce $80 million (farm value) of milk annually [8]. The dairies annually purchase inputs valued at about $67 million [9]. Most of the inputs originate within the region, and the dairy sector consequently represents an important part of both the producing and purchasing sides of the agricultural economy.

In addition, dairy farms provide about 90 percent of the milk inputs to the fluid and processed milk plants in the region. These operations, including fluid milk, condensed milk, cheese, butter, and ice cream and frozen desserts, produce $547 million of products per year [10]. There are three such plants in the service area and 20 in the four-county area [11], and they rely almost entirely on milk from service area dairy farms. Assuming plants are relatively uniform and of comparable efficiency, the processing plants in the Exchange Contractors' service area together produce $162

[8] Based on total output for the four-county area, taken from the IMPLAN data base, and the estimated 10 percent of the operations located in the service area as calculated above.

[9] Inputs include animals purchased for herd replacement.

[10] Based on the IMPLAN data base.

[11] Data for the four counties is based on [U.S. Bureau of the Census, 1993].

million of "direct" output per year [12] . Consequently, dairy farm production and processing within the Exchange Contractors' service area together produce $162 million of regional output annually.

[12] "Direct" output excludes the linkages from these to other industries, which are discussed in Chapter V.

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V Regional Dependence on Agriculture

The west side of the San Joaquin Valley includes the Exchange Contractors' service area and is one of the most important agricultural regions in the United States. Because of climate, soil, and water characteristics, it has a distinct comparative advantage over other regions for the production of many crops (some of which are grown in few other places in the world). When discussing the regional importance of a vital sector such as agriculture, however, it is critical that within-region variations be acknowledged.

Area versus Sub-Areas

The service area covers parts of four counties that are in the San Joaquin Valley. It includes several incorporated cities, Los Banos, Mendota, Firebaugh, Newman, Dos Palos, and Gustine. Los Banos is the most urban of the cities. Since 1980, its population has grown at a compound annual rate of 4.2 percent. Firebaugh has grown at 2.8 percent per year, Mendota at 2.4 percent, Dos Palos at 2.1 percent, and Gustine at 1.7 percent. Over that same period, California has grown 2.1 percent per year [California Department of Finance 1996].

The four counties in which the service area is located are very large, and the role and importance of agriculture consequently vary both within and between the counties. Farm production value in Fresno County, for example, is the highest among all counties in the nation, and agriculture is a vital part of Fresno County's economic base. Yet, agricultural production and services make up only 17 percent of wage and salary employment because of the recent growth in the trade, services, and government sectors in the region.

Farming is much more dominant in western Fresno County. For example, agricultural production and services represent 43 percent of total household employment in Firebaugh and 60 percent in Mendota [U.S. Bureau of the Census 1990]. Both of these areas are relatively isolated, and non-farming opportunities are limited.

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Farming and businesses directly and indirectly related to farming are the primary or only employers in some of these communities and surrounding vicinities.

Because of these within-region differences, the use of county-wide or state-level averages to describe the importance of farming is very misleading. Instead, the clear dependence of smaller communities and the entire regional economy on agriculture must be recognized and must not be obscured by the use of statistics for much larger geographic areas.

Ripple Effects on Other Sectors

The availability and the beneficial and efficient use of irrigation water are two of the key reasons that agriculture connects to so many businesses in the service area. Changes that occur at the farm production level pass through the entire regional economy. Farmers purchase equipment, chemicals, seed, and other supplies, as well as the services of labor and customer service providers. After harvest, crops produced move to processing firms and may be processed by many businesses before they are delivered in final form to consumers; examples are fruit and vegetable processors, cotton gins, and shippers and handlers. This web of economic activity generates wages and salaries in many different sectors, and the employees of those businesses in turn spend their earnings for many goods and services. Hence, any change which affects farms also affects firms which supply inputs to farmers and those which handle farm products outside the farm gate.

These linkages are characterized as both "backward" and "forward." Backward linkages refer to connections between production at the farm level and purchases by farmers of inputs to support production, such as fertilizer, feed, and machinery. As the demand increases for a particular crop, the farms producing that product purchase more inputs, hire more labor, pay more taxes, and earn more income. In turn, the increased sales made by the input sectors cause those firms to purchase more inputs from other sectors. The process continues until all increased demands for products and services from all sectors have been accommodated.

Forward linkages are connections between farms and businesses that handle or process products after they leave the farm, such as cotton gins, dairy processing plants, canning plants, and shippers and brokers. Farm products are inputs for these forward-linked sectors. Hence, an increase in the supply of key farm products makes possible an increase in the output of products using that input. As production and sales increase, demands for the inputs used in the products (such as labor, machinery,

and supplies) also increase. Again, this process continues until all increased demands for the inputs from all sectors have been met [13].

Backward Linkages

Both backward and forward linkages in the service area are substantial. The magnitude of the backward linkages is shown in Table 6. It shows employment and output "multipliers" for key agricultural sectors in the service area. They are taken from an input-output model developed for the four-county area (data limitations prohibited the development of a model to match the service area boundaries) [14]. Each multiplier shows by what amount total regional employment and output change with a unit change in employment and output in the specific agricultural sector. For example, the employment multiplier for dairy farm products is 3.43, meaning that with every job created in the dairy farm products sectors is associated the creation of an additional 2.43 jobs in all other sectors of the local economy. Hence, if the demands for the outputs of the dairy farm sector increase and cause employment on those farms to increase by 1,000, employment in other sectors will increase by another 2,430 people. These include other farm sectors, such as hay and feed grains, but in addition transportation, financial services, veterinary care, equipment repairs, and utilities.

Similarly, the output multiplier for cotton production is 2.23, meaning that a $1.00 change in cotton output causes an aggregate additional $1.23 output change in other sectors. If cotton acreage in the region expands and the value of cotton output increases by $1,000,000, that increase will lead to increased output of $1,230,000 in other sectors associated with cotton. These include farm chemicals, farm machinery, custom services, and transportation.

The weighted employment and output multipliers across all crop production sectors in the Exchange Contractors' service area are 3.49 and 2.03, respectively. The corresponding multipliers for the dairy farm sector are 3.49 and 1.96, respectively. It can be seen, therefore, that the ripple effects of changes in farm production are very large.

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[13] Since the process continues until all demands have been met, the input-output model is an example of a "general equilibrium" model.

[14] See Appendix A for a discussion of the development of the model.

Table 6
Employment Multipliers in Key Agricultural Sectors
Four-County Area Including the Service Area of the
San Joaquin River Exchange Contractors

Sector	Employment Multiplier	Output Multiplier
Dairy Farm Products	3.43	1.96
Cotton	5.19	2.23
Food Grains	2.17	1.91
Feed Grains	1.84	1.67
Hay and Pasture	2.13	1.88
Fruits	2.63	2.52
Tree Nuts	3.64	2.79
Vegetables	2.29	1.69
Sugar Crops	1.87	1.72
Miscellaneous Crops	1.73	1.82
Oil Bearing Crops	1.86	1.81

Farmers in the service area purchase large amounts of inputs that are produced both inside and outside the region. They purchase $98 million annually from local sources and $167 million annually from all sources of such inputs as feed grains, hay, boxes and packaging materials, chemicals and fertilizer, and machinery and equipment. They also utilize specialized providers for such services as soil preparation, planting, thinning, spraying, harvesting, and farm management (see Table 7) [15] .

[15] The data in the top section of Table 7 refer only to purchases of locally-produced inputs. For some items, such as farm machinery, the local content is relatively low and reflects only the value added margin by dealers in the service area; the manufacturing impacts are relatively low, as much of the machinery is produced outside the area. Similarly, the local content of insurance is relatively low, and reflects only the portion of premiums and other services that accrue to local insurance representatives. Most of the premiums flow to carriers, which are located outside the service area.

The extent of purchases of locally-produced inputs varies by crop. For example, 75 percent of inputs purchased by cotton farmers in the service area are produced within the 4-county area, and 25 percent are imported from outside the area. Some 57 percent of inputs used for hay production are produced within the area and 43 percent outside. For dairy farmers, about 55 percent of inputs are produced within the 4-county area, and 45 percent are produced outside.

The large "local content" of many purchased inputs substantiates the size and importance of the economy which has built up around crop and dairy production in the area. Fertilizer and farm machinery dealers have located in the vicinity because of the agricultural demands for their products and services. Hay producers have located in the area because of a ready market for their outputs in the dairies, feedlots, and other local livestock operations. In a more aggregate sense, the large employment and output multipliers discussed previously are a direct result of these many and extensive linkages. Consequently, any changes occurring at the farm production level have large impacts throughout the economy of the service area.

In addition to purchasing inputs, crop and dairy farms in the service area annually provide more than $28,355,000 in employee compensation, including wages and salaries and benefits. They pay more than $7,013,000 in sales and other taxes to local jurisdictions. And the farming enterprises provide over $127,800,000 in taxable self-employment income as well as rents and profits. These flows are important components of the regional economy, as income, rents, and profits are spent on a variety of goods and services, and taxes support the operations of local governments.

Table 7
Annual Purchases of Inputs by Farmers In the Service Area
San Joaquin River Exchange Contractors

Sector	Purchases ($)
Locally Produced Inputs	
Feed grains	$2,052,000
Hay	$14,392,000
Greenhouse/nursery products	$966,000
Services (plant, thin, misc.)	$39,061,000
Maintenance and repairs	$5,187,000
Boxes and paper packaging	$1,381,000
Fertilizers and chemicals	$2,706,000
Farm machinery	$1,421,000
Trucking and warehousing	$3,482,000
Wholesale distributors	$3,222,000
Banking	$2,837,000
Insurance	$2,400,000
Real estate	$9,708,000
Other	$9,025,000
Total purchases of locally-produced inputs	$97,840,000
Purchases of inputs produced outside area	$69,239,000
Total purchased inputs	$167,079,000
Employee compensation	$28,355,000
Business taxes	$7,013,000
Property and related income	$127,861,000

Forward Linkages

Farm products from the Exchange Contractors' service area are sold in many markets, both domestic and export. Some of the domestic sales are within the local economy and are used for inputs in other sectors. These local forward linkages are indicative of the "post-harvest" economic infrastructure that has developed around production agriculture in the service area.

The extent of these linkages varies by crop and livestock sector. For example, about 3 percent of cotton is processed locally in cottonseed mills, while 76 percent is sold in other domestic markets, and 21 percent is sold in foreign markets [16]. The local usage of feed grains is higher at 26 percent, while 69 percent is sold in other domestic markets and 5 percent is exported. Dairy farms are the single largest local user of feed grains, as they utilize 19 percent of production. Poultry and egg producers and feedlots use three percent.

Almost 80 percent of hay produced in the area is used locally, a higher local usage than for any other crop grown in the region. Most hay grown in the area is used locally because of the high cost of transporting such bulky commodities. Within the local area, 68 percent of the hay is used by dairy farmers, 5 percent by poultry and egg producers, 13 percent by cattle operations and feedlots, 5 percent in feed preparation, and 9 percent in other sectors.

The outputs of dairy farmers in the service area are used locally in the production of fluid milk, butter, cheese, condensed milk, and other dairy products. About 80 percent of final dairy outputs are exported from the 4-county region for other domestic markets.

Other important forward linkages in the area include the sales of feed grains to dairies and feedlots; of fruits and vegetables to producers of canned, dehydrated, and frozen foods; and of fruits to wineries and distilleries. Almost 21 percent of feed grains produced in the service area are used locally by dairies, poultry and egg producers, and feedlots. Ten percent of fruits and vegetables are processed locally into a variety of products, and another five percent of fruits are used in locally-produced wines and spirits.

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[16] Based on the IMPLAN data base. Some of the cotton that moves to domestic markets may eventually be exported, and the foreign export percentage may consequently be higher than that shown.

Farm outputs produced in the service area therefore stimulate activities in many businesses after the products leave the farm. These ripple effects impact almost all sectors in the regional economy.

C-096405

VI Irrigation

The availability of water for plant use during the growing season is the most limiting factor in crop production [Council for Agricultural Science and Technology 1988]. Short water supplies reduce crop yields and quality and increase the risks of farming. Irrigation helps to reduce these risks by increasing the level and uniformity of crop yields and improving crop quality.

Farmers have been irrigating in the western San Joaquin Valley for more than 100 years. They initially used Sierra Nevada runoff flowing to the Kings and San Joaquin Rivers. [17] By the early 1900s, groundwater was used extensively following the discovery of a large, deep, confined aquifer system [Prokopovich 1989]. Irrigated acreage expanded rapidly following World Wars I and II and the completion of the DMC in the early 1950s. Consequently, while groundwater usage remained an important part of irrigation water supplies, surface water was substituted for some of that usage. With the increased availability of ground and surface water, the acreage of irrigated cropland in the San Joaquin Valley has increased more than 80 percent.

The Exchange Contractors divide the total supply of DMC water based on historical formulas and on joint negotiations when changes are considered. Allocations and operating practices are based on the objective of obtaining the greatest beneficial use from the water resources available collectively to the Exchange Contractors and to farmers within the service area.

Irrigated agriculture has been instrumental in developing and sustaining the regional economy of the service area. Farm-level water use is highly efficient, as the Exchange Contractors effectively utilize pricing and other incentives to maximize the beneficial use of water throughout the service area.

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[17] Much of this history can be found in [Treadwell 1931].

Surface and Ground Water Supplies and Use

While the beneficial and economic crop production uses of surface water in the service area are clear, the other uses of this water are also important. For example, irrigation and canal seepage are important components of groundwater recharge programs. These programs help to mitigate the overdraft situation in the surrounding area and in parts of the service area itself. The recharge programs also help to provide a water supply to other areas that do not have surface water available. In addition, the Exchange Contractors have lift pumps that recirculate collected tailwater for irrigation. Any tailwater not reused flows into the San Joaquin River, and the flows are available for groundwater recharge, instream purposes, and diversions for wildlife and by downstream irrigators.

Parts of the Exchange Contractors' service area receive most or all of the irrigation water required for crop production from the DMC (or in emergency conditions, the San Joaquin River). In other sub-areas, however, surface allocations are insufficient for the local cropping mix. In those areas, groundwater is pumped, either by the individual Contractor (district) or by the farmers residing within those districts, or both. The amount of groundwater pumped varies annually depending on the amount of surface water delivered and on total crop needs.

Irrigation Efficiency and Water Conservation

Growers in the service area are skilled, efficient water managers who operate at maximum or near maximum reasonably-achievable level of irrigation efficiency. Many of those able to use sprinkler and drip irrigation have converted to those systems. Other irrigators have been unable to change systems because of slope, soil characteristics, or other issues. While different irrigation systems might reduce application requirements in some areas, groundwater recharge would be adversely affected. Reduced recharge would cause groundwater quality to deteriorate and would also cause pumping costs to increase.

Regardless of irrigation methods used, farmers in the service area attempt to utilize water as efficiently and carefully as possible. They keep excessive runoff and excessive deep percolation to a minimum, and they have adopted practices which reflect their understanding of both the monetary and intrinsic value of the water resource. Farm operators closely monitor soil moisture and weather conditions in managing irrigation in order to meet the dual objectives of avoiding waste and minimizing crop stress. They use their own experience and information from a variety of other sources to determine when and how much water to apply and how to operate their irrigation systems for peak efficiency.

Farmers in the service area purchase and improve irrigation systems in order to attain uniform, high crop yields and to reduce the chances of crop failures when water supplies are short. They regularly invest in new or improved irrigation systems if the increased revenues expected from those improvements exceed the costs and if water supplies are dependable.

The Exchange Contractors have developed and implemented a variety of progressive measures to encourage conservation and efficient water use. These include tiered pricing, loan programs for purchase and installation of water-conserving equipment, and technical assistance. Exchange Contractors have utilized tiered pricing since the late 1980s. Prices for the tiers have been set to recover costs and to discourage water use at particular times during the year. In some cases, revenues from the higher-priced tier have been used to fund conservation loan programs.

Conservation loan programs have been established to provide farm operators with low interest rate loans for on-farm water conservation projects. Such projects include surface or underground pipelines, lined ditches, sprinkler or drip systems, land leveling, and tailwater reuse systems. Projects completed to date result in water savings throughout the service area of more than 10,000 acre-feet annually.

Water Transfers

The Exchange Contractors regularly participate in water transfers as a provider to users outside the service area. The primary users are other Central Valley Project water districts and both National and California wildlife refuges.

VII Future Conditions in the Service Area

Agriculture has been the economic nucleus of the San Joaquin River Exchange Contractors' service area for more than 100 years. Farmland has been irrigated continually since the early years of California statehood, and a large, diverse agricultural production sector has built up as a result. So also has a comprehensive infrastructure of industries selling to and buying from these enterprises. The diversity and completeness of the agribusiness sector in the area has enabled it to rebound from the unavoidable cycles which characterize agriculture.

Parts of the San Joaquin Valley have been urbanized and have become less dependent upon agriculture. While Fresno, Merced, and Modesto, for example, certainly remain important parts of the San Joaquin Valley agricultural sector, the size of agriculture in these cities has declined relative to trade, services, and other industries that have grown together with population.

The California Department of Water Resources (DWR) projects that there will be rapid population growth and increased urban water demands in the parts of the valley that include these and other urbanizing cities: the Valley East Side (VES) and the Eastern Valley Floor (EVF) [California Department of Water Resources 1994]. DWR projects population increases of 836,000 and 224,000, respectively, in these two areas between 1990 and 2020. Annual water demands are expected to increase by 326,000 acre feet and 54,000 acre feet, respectively, under normal conditions. During this period, irrigated crop acreage is projected to decline by 50,000 acres in the VES and to remain stable in the EVF. Annual applied water demand in agriculture is projected to decline by 352,000 acre feet and by 77,000 acre feet, respectively.

DWR projections also indicate that agriculture will remain a dominant influence in the Valley West Side (VWS) planning subarea, which includes most of the San Joaquin River Exchange Contractors' service area. The Agency projects that irrigated crop acreage will remain stable between 1990 and 2020. Nonetheless, annual applied water demand in agriculture is projected to decline by 149,000 acre feet. It is likely that changing crop patterns and improved irrigation technologies will account for most of this decline.

There is little evidence to suggest that the San Joaquin River Exchange Contractors' service area will change from its agricultural orientation. Farms have been in the same families for many generations, and farmers have a sincere and deeply-felt interest in preserving and sustaining the land. History has shown that agriculture is the highest and best use for land in this area, and the region has a competitive advantage in the production and use of many crops. Certainly parts of the area such as Los Banos will undergo urbanization, but the climate, soils, water, and other resources in this region make it most suitable for agribusiness rather than residential, commercial, or industrial uses.

REFERENCES

Alward, G., et. al., 1989, Micro IMPLAN Software Manual, Regents of the University of Minnesota, Minneapolis.

Archibald, Sandra, 1990, Economic Profile of Agriculture in the Westside of the San Joaquin Valley, Prepared for the Federal-State San Joaquin Valley Drainage Program, Sacramento.

California Department of Food and Agriculture, January-February 1994, Milk Production Cost Index, Sacramento.

California Department of Food and Agriculture, 1996, California Agricultural Resource Directory, Sacramento.

California Department of Water Resources, 1994, California Water Plan, Bulletin 160-93, Sacramento.

Carter, Harold O., and George Goldman, 1996, The Measure of California Agriculture: Its Measure on the State Economy, Revised Edition, University of California, Division of Agriculture and Natural Resources, Oakland.

Council for Agricultural Science and Technology, 1988, Effective Use of Water in Irrigated Agriculture, Report No. 113, Ames, Iowa.

Minnesota IMPLAN Group, 1994, Micro IMPLAN User's Guide, Stillwater, Minnesota.

MIG Inc., 1996, MIG Technical Analysis Guide, Stillwater, Minnesota.

Prokopovich, Nikola, 1989, Irrigation History of the West-Central San Joaquin Valley, Prepared for the Federal-State Interagency San Joaquin Valley Drainage Program, Sacramento.

Treadwell, Edward F., 1981, The Cattle King, Western Tanager Press, Santa Cruz, California.

U.S. Bureau of the Census, 1992, Census of Population and Housing 1990, Data for California Cities, Washington, D.C.

Villarejo, Don, 1996, 93640 at Risk: Farmers, Workers and townspeople in an Era of Water Uncertainty, California Institute for Rural Studies, Davis.

C-096412

APPENDIX A THE USE OF INPUT-OUTPUT ANALYSIS

IMPLAN is a system of software and databases used to construct regional economic models. It is based on input-output (I-O) methodology, which quantitatively measures the interdependence among economic sectors. Each sector not only produces goods and services, but also purchases goods and services for use in the production process. Quesnay originally conceptualized these relationships in 1758. Leontief published an I-O system of the United States economy in 1936.

The IMPLAN approach is based on I-O methodology that has been modified for regional data retrieval, model development, and impact analyses. It can be used to analyze the distinct regional characteristics or impacts associated with broad-level policy changes or economic problems. IMPLAN is a "non-survey" I-O system, as it does not require primary, survey-based data. IMPLAN is an important tool to analyze regional impacts of policy changes because of the ease with which specific regional or local information can be incorporated into a model. A regional I-O model is used in this study to estimate multipliers, input purchases, local product usage, and other quantitative measures pertaining to agriculture in the San Joaquin River Exchange Contractors Water Authority service area.

IMPLAN was developed for the US Forest Service by the University of Minnesota to assist in land and resource management planning issues. It has been used since 1979, initially as a mainframe-based, batch-mode program. It was converted to an interactive, menu-based microcomputer program in 1989 and has been refined continually since then. Details may be found in [Alward, et. al. 1989]; [Minnesota IMPLAN Group 1994]; and [MIG Inc. 1996].

Regional Analysis

Regional analysis is a form of economic analysis that recognizes the distinctness of a geographical area in terms of its resources, industries, and relationships with other areas. In general, smaller regional economies are more dependent on trade with other

regions for "imports" and "exports" of goods and services than are larger regions. Regional growth is enhanced by the outputs of its export industries. In this study, agriculture and sectors related to agriculture export many of their products outside the region and are consequently important contributors to growth in the area.

Regional I-O analysis is based directly on the Leontief framework developed for the national economy. Regional I-O models are extensions of that basic structure that reflect regional differences in production processes. As an application tool, IMPLAN is able to capture these relationships in straightforward fashion. The matrix algebra is cumbersome, though relatively quick with high-speed microcomputers. The matrix steps are discussed in [MIG 1996].

Computational Process

The steps in the development and use of an IMPLAN model are relatively straightforward because of the software itself. However, logic and interpretation are required at each stage to minimize the potential for inaccuracies and to maximize the usefulness of the model.

Define Problem

IMPLAN can be used to analyze such diverse issues as the impacts of changes in regional agriculture, the closure of military bases, entrance of new industries into an area, construction of recreational facilities, and changes in national or local government policies. The specific problem must be defined in terms of the resources it will affect, in which industries, and in which locations.

Define Study Area

IMPLAN is a county-based application, and a study area can include one or more counties or entire states. The study area defined for a problem is important because the impacts related to the problem depend directly on the size of the area and linkages among the industries. The study area should center around the location of activities for which impacts are to be measured. The area should include the locations of principal buyers and sellers of the goods and services central to the analysis. If household purchases of the goods and services are important, the study area should also include the locations of consumers. The area should be sufficiently large to include the industries and consumers which will be affected by the events being analyzed, but not so large as to lose resolution of the most-impacted sectors.

The study area may include the locations of key backward and forward-linked industries to the sectors of interest. Backward linkages are those between an industry and its suppliers, e.g., between vegetable growers and farm chemical dealers. Forward linkages are those between an industry and other industries which use or add value to the product, e.g., between rice growers and rice mills. I-O models capture backward linkages only. For that reason, regional models should account for any important forward linkages within the study area. For this analysis, the study area was defined as the four counties in which the San Joaquin River Exchange Contractors Water Authority service area is located

Compile and Edit Regional Data and I-O Accounts

The IMPLAN database includes 21 economic and demographic variables for 528 sectors for all counties in the United States. The analysis in this study utilizes the 1993 IMPLAN database, which was the most current at the time the study was begun. The data are taken from numerous state and federal sources such as the National I-O accounts, the National Income and Product Accounts, Census data, and a host of other published sources. However, many components must be estimated because disaggregated economic data are frequently unavailable at the county level.

Because of the required estimation, the key data for the counties in a region must be reviewed and validated. For this study, the principal IMPLAN database variables analyzed were employment, agricultural output, regional purchase coefficients, and production functions.

Employment

State employment data are the most consistent, comprehensive source for the counties in the study area. California data were obtained from the Employment Development Department (EDD). Since these data exclude self employed and sole proprietorships, Regional Economic Information System (REIS) information was used to supplement state data 18.

The state employment and REIS data were then used to validate the employment and income data in the IMPLAN data base for key IMPLAN sectors in the study area. The variance between the two data points for each key sector ranged from 2 percent to

[18] U.S. Department of Commerce, Economics and Statistics Administrative 1994.

17 percent; this was judged to be acceptable. Because other comprehensive data alternatives were unavailable, the IMPLAN employment data were not changed.

Agricultural Output

The IMPLAN database contain 23 agricultural industries. The 1993 employment and income data for these sectors are based primarily on data from the 1992 Census of Agriculture. County Agriculture Commissioner reports for the California regions were used to evaluate IMPLAN agricultural output data in greater detail. Generally, the IMPLAN data were found to be consistent with those in the Commissioner reports.

Regional Purchase Coefficients

A regional purchase coefficient (RPC) measures the fraction of a locally-produced good or service that is used to meet local demand for that good or service. RPCs are greater than zero and less than one. The default values in the IMPLAN database are based on a combination of predictive equations and observed values outside IMPLAN. RPCs for key industries in the four-county study area were reviewed for reasonableness and were adjusted as appropriate.

Derive Multipliers

A multiplier measures the difference between an initial change and the final effects of that change. Multipliers can express the direct or combined direct and indirect effects of a change. Direct effects are those that occur in regional industries from which a particular sector purchases and are sometimes called first-round changes. Indirect effects incorporate two measures: (1) the regional production necessary to support changes in a given industry's direct requirements; and (2) the regional production that is stimulated by consumer demand caused by payments for labor by a given industry. The second of these is sometimes referred to as induced effects.

"Type I" multipliers include direct effects and "Type III" multipliers represent the latter. Type I multipliers include only the effects of inter-industry purchases. Type III multipliers include the effects on household spending induced by the changes being analyzed. As industry outputs change, income payments to workers in those industries change, and these in turn induce changes in consumer spending. These effects work through the economy in a series of rounds, and are summarized by the Type III multipliers.

C-096416

Analyze Impacts

Impact analysis involves the measurement of direct, indirect, and induced output, employment, and income effects of changes in final demand in sectors of the regional economy. Impacts are calculated using estimated multipliers and the changes in final demand.

Impact analysis is used in this study to measure both direct and indirect effects of changes in agricultural output in the San Joaquin River Exchange Contractors Water Authority service area. It incorporates the essence of the RPCs discussed above and, with adjustments to account for forward linkages, measures the effects of the agricultural sector on the regional economy that includes the service area.